

Analysis of Adsorbed States of an Ionic Liquid in Slit-shaped Carbon Nanopores by an IR measurement

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Nanoporous carbons have been extensively studied from the viewpoint of the applicability to materials for electric double layer capacitors.¹⁾ The relationship between a normalized capacitance and a pore size of nanoporous carbon having different pore widths has been shown; the maximum capacitance is obtained when the pore size is in the same range as the maximum ion dimension.¹⁻³⁾ The structures of liquid molecules and solvated organic ions confined in carbon nanopores were studied by an X ray technique; the liquid molecules are closely packed in the pore without an explicit ordering in the absence of the salts and the distribution of the liquid molecules along the pore width is quite uniform, whereas the addition of an organic salt gives rise to considerable variations in the distribution of the liquid molecules. The distribution has double peaks near the monolayer positions on the both pore walls. This indicates that the addition of the organic electrolyte promotes the orientation of the liquid molecules along the pore walls. The structure change of liquid molecules should be related to the specific pore size.⁴⁾ We have been studying specific structures and properties of ion liquid molecules confined in nanopores by using synchrotron X-ray diffraction (XRD), NMR, and IR measurements, because ionic liquids are very interesting and gathering much attention as a new kind of salts.

In this paper, we report structural and vibrational specificities of an ion liquid, 1-ethyl-3-methylimidazolium tetrafluoroborate (EMI BF₄), confined in carbon nanopores of activated carbon fibers with different pore sizes. The results were obtained by XRD and FT-IR measurements. XRD analysis showed that the distance between an EMI ion and a BF₄ ion in the confined system becomes shorter than that in the bulk system. The peak intensities in IR spectra markedly decreased for molecular vibration modes perpendicular to the plane of the imidazolium ring of an EMI ion confined in the carbon nanopores compared to that in the bulk state. These results exhibit that the molecular motion should be strongly restricted in the carbon nanopores.

References

- 1) P. Simon and Y. Gogotsi, *Nat. Mater.*, **2008**, 7, 845.
- 2) J. Chmiola et al., *Science*, **2006**, 313, 1760.
- 3) C. Largeot et al., *J. Am. Chem. Soc.*, **2008**, 130, 2730.
- 4) A. Tanaka et al., *J. Am. Chem. Soc.*, **2010**, 132, 2112.